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POLARITY IN THE WEEPING WILLOW

By E. A. Andrews

The experiments of Vöchting showed marked polarity in the new growths from cut-off twigs of the osier willow when very young, but in older twigs and in some other species of willow less marked polarity. The following observations upon the older twigs of the weeping willow (*Salix babylonica*) show new growth of pieces without observed polarity. Being manifestly incomplete, they are published chiefly as suggestive of problems to be solved.

In October before the leaves had fallen, twigs 10–15 mm. thick and 30 cm. long were cut from a young weeping willow about ten feet high. The branches used were erect and not the pendent twigs. When these were put with one half in the water and the other in the air (not especially moist) they eventually formed roots in the water and leaf-buds in the air, whether the twigs were inverted or not. During the winter the leaf-buds elongated as branches 15 cm. long. The only leaves formed under water were from visible buds while in the air there were leaves formed in addition to those coming from visible buds. It was thought that the roots came out sooner from the basal ends in water than from the apical ends in water, but this may have been due to differences in temperature caused by one set of jars being nearer to the source of heat. Transplanted into earth, some lived several months, but both the inverted and the non-inverted twigs died.

In March and April, when the leaves were first showing green but had not yet expanded, twigs of the same small tree showed a marked ability to form roots from any part in water and leaves from any part in air, without difference between basal and apical

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regions. Thus sticks 10–15 mm. thick and 60 cm. long were cut across into three and four pieces and the pieces of each tied in a bundle so that successive pieces of the same stick were alternately inverted and not inverted. Larger sticks 30 mm. thick and 90 cm. long were cut into pieces each 45 mm. long and smaller sticks 8 mm. thick and 60 cm. long were cut into pieces 30 cm. long. In each case the successive pieces were tied together side by side, one inverted the other not. In all cases the bundles standing upright in water with the upper half in the air showed within 48 hours roots growing in the water and leaves growing in the air, on all the pieces of sticks.

In those bundles of sticks cut across into *two* pieces the following combinations occurred. (1) The basal half-piece put out roots from its basal and leaves from its apical part while the apical half-piece put out leaves from its basal and roots from its apical part. (2) The basal half-piece made leaves from its basal and roots from its apical part while the apical half-piece made roots from its basal and leaves from its apical part. (3) The basal half-piece made leaves from its basal and roots from its apical part while the apical half-piece made leaves from its basal and roots from its apical part. In the first case the cut surfaces that used to join at the middle of the stick were side by side in the air; in the second case they were side by side in the water; and in the third case they were separated so that one was in the air and the other in the water.

The same response to air and water was shown again in a twig cut into basal, middle and apical pieces, which made roots from the basal and leaves from the apical part of the basal piece, leaves from the basal and roots from the apical part of the middle piece, and roots from the basal and leaves from the apical part of the apical piece. And when these three pieces were placed together again there were seen along the length of the twig: first some roots, a number of new side branches, another set of like branches, a second set of roots, a third set of branches and finally a third set of roots.

Even more striking appeared the succession of new growths upon a forked branch, when the pieces were restored to their natural sequence after having made new roots and shoots. Of the four pieces the basal made roots from its basal part and leaves from its apical part while the next piece, which was Y-shaped, made shoots from its basal part and roots from both its apical parts. Of the two terminal pieces, one made roots from its basal and shoots from its apical part while the other made shoots from its basal and roots from its apical part. In all cases roots arose in the water and shoots in the air.

The effect of water and of air was again shown in the case of a piece an inch and a half thick and nearly three feet long, which had put out roots from the basal part in water and shoots from the apical parts in air, but subsequently when so placed that water dripped upon its apex and ran down its entire length without accumulating at the base, put out new shoots amidst the basal roots and new roots amidst the apical shoots.

To see how very short lengths of pieces would behave, a few pieces were cut 32 mm. wide and from 8 to 65 mm. long. These were floated in shallow water, some base upward others apex upward. Those 65 mm. long made leaves in the air and roots in the water no matter which end was up. Some 17 mm. long made only leaves. One very short disk 32 mm. wide and 8 mm. deep put out one slight beginning of a shoot and of a root and here the root was above the shoot and toward the apex end. After many days these experiments were obscured by the drying out of the water.

Since roots were so readily made in the presence of water and shoots in the presence of air, some twigs were hung up in moist air after the method of Vöchting but with access of light and exclusion of free circulation of air. Hanging vertically, nearly, in moist air, these twigs might be expected to show any polarity they possessed, without the masking effects of the strong stimuli, water and air, applied in most of the above experiments at opposite poles.

Sticks 10 mm. thick and 60 cm. long were cut into three and four pieces, 15 to 20 cm. long and tied together in bundles so that successive pieces of each stick had base and apex downward alternately. The bundles were hung nearly vertically in a belljar standing in water. In all the pieces roots came out all along the length and shoots all along the length. No difference was observed between the upper and the lower end of any stick whether it was inverted or not. With approximately equal conditions of air and moisture all along the sticks, the roots and shoots came out everywhere alike. They did not, however, come out from every part of the surface but from irregularly scattered spots widely distributed along the entire length and with no observed polar distribution. In a specific case of a twig cut into four pieces and suspended so that the original basal piece had its apex above, the next piece its apex below, the third its apex above, the fourth its apex below ; it was found that when the four pieces were placed together again in their original sequence they formed a long stick that bristled with short roots and with leaves along its entire length.

In these experiments in moist air, a callous tended to form over the cut surfaces, but no new growths were made from the cut surfaces nor from near the cut surfaces.

The roots came out from unseen lateral beginnings, while some of the leaf-bearing shoots came from visible buds and others from unseen beginnings.

In most cases the roots came out in groups of several close together and almost always in a row one above the other like fingers of a hand. While the roots could be seen for some days pushing out the green bark as conspicuous elevations before they broke through, there were many more elevations due to the swelling and bursting of lenticels. These changed a few hours after being put into water, or moist air, and finally exposed wax-like masses that made the surface of the twig thickly scattered over with white areas.

It would seem that these twigs of weeping willow contained very large numbers of lateral beginnings of shoots and of roots all along their lengths, or else have the power to form such beginnings, or else have both formed and facultative shoots and roots. When both water and air were present, large numbers of such organs grew forth all along cut-off twigs without observed reference to what was apical or basal. When, however, water and relatively dry air were applied to opposite ends, a polar growth resulted with reference to these conditions only and not with reference to what had been basal or apical in the twig before separation from the tree. Apparently, possible leaves failed to be formed in water without much air and possible roots failed to be formed in air without much moisture.

In many of the above experiments twigs of an undetermined native willow were used in the bundles with weeping willow and without different results. The assumption that the weeping willow has acquired these innumerable centers of new growth as a means to produce new trees when branches happen to be broken off, may not be in the line of fundamental explanations to be sought for.

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NOTES ON SOME SOUTHERN ILLINOIS PLANTS.—III

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The two species of *Jussiaea* which extend into Illinois, *J. diffusa* Forsk. and *J. decurrens* (Walt.) DC., are of characteristically austro-riparian habit, and are always found in swamps or along streams. The former species is well distributed along the Mississippi on muddy banks with a gradual slope, and is able to live farther down the bank towards the water than any other plant except *Eragrostis hypnoides*. It is nowhere common and has so far not been observed except along the river. *Jussiaea decurrens*, on the other hand, is not found on the Mississippi side, but only along the Ohio River and its tributaries. It is very abundant among the Tertiary hills in Massac and Pulaski counties, and along the small streams flowing southward through the Carboniferous and Devonian regions in Pope and Hardin counties. The limited amount of field work done north of the Ozark uplift has not as yet revealed its presence there.

Jussiaea decurrens is of some interest because of the development of aërenchyma upon its subaquatic roots. This peculiarity